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All Equal under the Sun. A Normative Analysis of the Duckworth-Lewis Rule*

Kurt Devooght

This essay identifies the concept of equality implicit in the Duckworth-Lewis rain rule and confronts it with the responsibility-sensitive egalitarian ideal advocated by such philosophers as Rawls, Dworkin and Scanlon. While exposing the relatively ad hoc nature of the rule, arguments are forwarded in favour of a more explicit rendering of the rule's conception of equality. To this end, a more egalitarian ideal is developed based upon the principle of responsibility. According to such a concept of equality, compensation and reward are respectively defined in relation to the limits of one's responsibility: that is, while one should be compensated for the consequences of events deemed beyond one's responsibility, one should nevertheless be able to keep the fruits of actions for which one is held responsible. The possible implications of this approach for the game of cricket are elaborated in detail.

One of the defining characteristics of cricket is the fact that both teams do not, in a qualified sense, compete simultaneously but consecutively. The team batting first is able to score runs while the opposing side aims to take wickets. Only once the team batting first has completed its innings, can the fielding side take the pitch in an attempt to reach the established target. This kind of consecutive play is rather exceptional among the most popular (field) sports, [1] arguably because such forms of competition are too often exposed to criticisms of unfairness, unequal opportunities and – sometimes even literally – an uneven playing field. Indeed, those sports where levels of performance are particularly vulnerable to the influence of external conditions (such as weather, light, crowd involvement, etc.) are especially exposed to these criticisms. Situations where external conditions influence the outcome of a game to an excessive degree are often considered to undermine the ideals of fairness and equality – two fundamental ideals essential to the constitution of any game or sport. It should come as no surprise that cricket, in particular, is extremely susceptible to the

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influence of such external conditions as weather and light but also the condition of the pitch and the outfield and even the state of the ball (which in turn depends on the dampness of the outfield among other things). All these elements regularly play a significant role in determining the outcome. Add to this that play is often spread over several days and one could easily understand that the aforementioned criticism applies a fortiori to the game of cricket.

This might all sound quite disturbing for the game of cricket. The game of cricket is traditionally thought to promote the virtues of fairness and equality – a fact captured comprehensively by the expression, 'that's not cricket'. Despite this, however, the game itself is conceived such that it is extremely vulnerable to unequal playing conditions. (Though it sounds paradoxical, it may well be that fairness, justice and equality in relations between players are emphasized so vehemently in cricket precisely because these aspects are lacking in the influence of external conditions outside the scope of the players' performance and responsibility.) The unfairness inherent to the game's conditions of practice (or at least the vulnerability of the game to those conditions) should not, it is thought, spill over into the domain of the players' behaviour on and off the field. The outcome of the game often slips through the fingers of the players despite the quality of their performance and, worst of all, nothing at all can be done about it. It could be argued that this situation at very least teaches cricketers to play and enjoy cricket with the right degree of detachment and relativism.

Recently, however, a lively debate has arisen concerning certain particular methods aimed at correcting the imbalance to which cricket is susceptible with regard to the effects of rain in interrupted One Day International (ODIs) or Limited Overs International (LOIs) cricket matches. Such methods – the so-called rain rules – re-calculate the target for the team batting second after play has been interrupted at some point during the day. Although rain rules have long been in place, the attention that has recently accompanied the introduction of a particularly sophisticated rain rule has been allowed to obscure the basic function of rain rules. Rain rules, in essence, attempt to correct, under exceptional circumstances, for the dependence relation between the result of a particular game and the external conditions in which it is played. The far-reaching consequences of this fact for the very nature of the game are often neglected in recent debates. The fact that rain rules are now an accepted part of the make-up of one day cricket seems to open the door onto a slippery slope where all kind of external conditions may be adjusted for, thus potentially changing the appearance of the game dramatically. Why, we then might ask, is it so important to allow adjustment for the influence of external conditions? How are equal opportunities for both teams guaranteed? Is this in accordance with the spirit of the game, and if so, in the name of which ideals is this adjustment allegedly effected? These and many other philosophical questions arise although only some will be touched upon here.

The main point I wish to make in this essay is the following. Recently, rules have been put in place which not only reset the target for rain interrupted games but also and, in so doing, 'correct' – be it explicitly or implicitly – for external conditions. The re-calculation and thus the implicit allowances are, in my view, rather ad hoc and demand a more solid ethical underpinning. It shall be forwarded that rain rules in general can only be accepted provided that their (philosophical) foundations and consequences are well thought-out in advance.

In what follows I first briefly describe the history of rain rules in the game of cricket (section 1). Section 2 extensively lays out the Duckworth-Lewis method, which is the rule currently employed by the ICC. In section 3, I scrutinize the advantages and the drawbacks of this method in the light of some properties a good rain rule should possess. The question as to whether the Duckworth-Lewis rule is a fair rule from a responsibility-sensitive egalitarian point of view is addressed in section 4.

Rain Rules: A Brief History

The common practice in dealing with interrupted LOIs up until 1992 was to compare the run rates (the total number of runs scored divided by the number of completed overs) of the competing teams. The team with the higher run rate was declared the winner. This rule, however, tended to benefit the team batting second (henceforth referred to as Team 2) at the expense of the team batting first (Team 1). This led to the common practice of inviting the other team to bat first if rain was expected. As a result, this rule has often been accused of not being sufficiently 'strategy-proof', that is, of not possessing the property of tactical neutrality as decisions could be made by the second team in order to exploit the rule to their advantage. However, it is not the potential for strategic play that seems to be deficient in the run-rate method, since tactics belong to the very essence of the game of cricket. The point is that the first team does not have the same strategic options as the second team and, in this sense, the rule does not provide both teams with equal opportunities. Resistance to this rule appeals, therefore, to the ideal of equality rather than to that of strategic neutrality.

Realizing that this rule is biased towards the side batting second, the Australian Cricket Board introduced its 'most productive overs' rule during the 1992/93 season. This rule calculates the target for Team 2 by taking the n highest scoring overs of Team 1 where n is the number of played overs (for example, 40 if 10 overs are lost due to rain). Ironically, this rule was now considered as tending to favour the side batting first and blatantly unfair to the team batting second. [2] Why is this so? Suppose that Team 2 requires 20 off 19 balls to win, when a short shower takes three overs away. The reset target would now be 20 off 1 ball since the three least productive overs are deduced from the original target (which we may suppose for the sake of argument were three maiden overs in this case). However, this seems to be unfair and even ironic: the second team's excellent bowling (three maiden overs) in the first innings is now turning against them. It would have been better for Team 2 in this case if Team 1 had reached the same total score without any maidens. In this case, the second team is not offered the opportunity to reap the rewards of some excellent bowling. To curb this unfairness and other alleged blemishes and glitches, a series of other rules such as the parabola method and Clark curves were devised. While all had relative success, in the end, they all proved to be unsatisfactory. The cricketing world had to wait for a rule that could rally support on a much larger scale.

The Duckworth-Lewis Method Explained

The Duckworth-Lewis (D/L) [3] method of resetting targets in interrupted one-day cricket matches was trialled in 1997 and chosen for use in 1998. Since then it has been applied on many occasions including the 1999 and 2003 ICC Cricket World Cup. The D/L method is adjusted almost yearly to accommodate for flaws in the method. I shall restrict my examination to the 2002 Standard version. A Professional version was introduced in October 2003, in an attempt to ensure fairness to both teams in matches where Team 1 sets an exceptionally high total.

One of the most important innovations of the D/L method is that it acknowledges that there are two resources available to the teams with which to make as many runs as they can: the number of overs they receive and the number of wickets they have in hand. Recall that the previous rules did not take account of the number of wickets in hand at all. This fact is striking, as it seems clear that any fair rain rule should take into account, in one way or another, the quality of the performance of both teams. Including the number of wickets in hand is a step in that direction. Duckworth and Lewis then argue that a particular combination of these two resources – wickets in hand and overs remaining – must be used to re-calculate the target of Team 2. Basically, the D/L method converts the number of wickets lost and the number of overs remaining into a 'resource remaining' percentage. At the start of the innings, this is of course 100 per cent, but as overs are completed or wickets fall this 'resource remaining' percentage falls.

Let us consider the D/L system as a three-step procedure. The first step of the procedure is conceived to determine the (expected) number of runs a team would have scored from the extra resources at their disposal in the absence of a curtailment of their innings. The method is based on the following formula, which calculates $Z(u,w)$, the expected number of runs to be scored when u overs are left to be played ($0 \leq u \leq 50$) and w wickets have been lost ($0 \leq w \leq 9$):

$$Z(u, w) = Z_0.F(w)\left[1 - \exp\left(\frac{-b_0 u}{F(w)}\right)\right]$$

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The function F(w) is assumed to be a positive decreasing function and could be interpreted as the proportion of the expected number of runs with w wickets lost relative to the expected number of runs without any wickets lost (where both terms are seen as if there was an infinite number of overs remaining). For instance, F(0) must be 1. This function was estimated based on D/L's knowledge of cricket. The estimates of the positive constants Z_0 and b_0 were obtained by fitting the model to some data from past first class matches. The term $-b_0/F(w)$ could be interpreted as a decay parameter that varies with w. The abbreviation exp (for exponential) indicates that a certain irrational number (e $=$ 2.71828 . . .) is to have as its exponent the expression in parentheses. D/L (1998) does not list the values of the constants due to what its exponents call commercial confidentiality.

What to say about this first step? As was already stated, an important breakthrough of the D/L rule is that it acknowledges that there are two resources available to the batting side and that a combination of these two resources must be used to reset the victory target. There is however certainly more than one way to evaluate the trade-off between resources. One could, in this respect, ask some intriguing questions: When could one call this a 'fair' trade-off? Are both resources equally important? If not, what are the relative weights of both resources? What is the justification of setting the weights as they are? Another aspect is raising eyebrows as well. It is quite reasonable to search for the hypothetical value of the score if the innings had not been curtailed. This is of course a counterfactual exercise with a hypothetical outcome, calculated on the basis of a set of data of past matches. It strikes me as odd that the expected hypothetical total is based on some kind of averaging of results from the past rather than based on the actual run-scoring trajectory of the team before the interruption. The latter method definitely reflects much better the actual (external) conditions of play, the performance of the team, the strategy decided upon and the tactics involved. One should not forget after all that one is dealing with interrupted matches due to bad weather, which usually does not come unexpected. Bad conditions might already have influenced the conditions before the interruption. In my view, an average of past matches does not mirror the (external) conditions of the first team in the best possible way. One could summarize this objection in a lapidary manner: 'The second team has to beat (the average of) the game, rather than the other team'. Perhaps the next step will demonstrate some improvement on this.

The second step is to calculate from the number of expected runs the more advantageous quantity of the percentage of resources remaining. The proportion of resources remaining is defined as P(u,w), when u overs are left to be played and w wickets have been lost. It can be obtained easily once one has $Z(u, w)$ for $0 \leq u \leq 50$ and $0 \leq w \leq 9$.

$$P(u, w) = \frac{Z(u, w)}{Z(50, 0)}$$

Table 1 Extract from the Table of Resource Remaining Percentages (2002) P(u,w) values where *u* is Overs remaining and *w* is Wickets taken

w	**0**	**2**	**5**	**7**	**9**
50	100	85.1	49	22	4.7
40	89.3	77.8	47.6	22	4.7
30	75.1	67.3	44.7	21.8	4.7
25	66.5	60.5	42.2	21.6	4.7
20	56.6	52.4	38.6	21.2	4.7
10	32.1	30.8	26.1	17.9	4.7
5	17.2	16.8	15.4	12.5	4.6

The nominator is the average runs of all the past matches taken into consideration and calculated to amount 235 (or whatever number decided upon for the appropriate class of game). [4] The percentage of resources remaining is then the number of expected runs divided by 235. Table 1 gives the values of P(u,w) for some u's and w's, allowing us to determine the percentage of resources remaining from these positions in an innings.

For instance, suppose that after 30 out of 50 overs a team has lost 2 wickets. From the table one easily derives that the percentage of resources remaining with 20 overs left P(20, 2) is 52.4 per cent. Suppose now that it starts to rain cats and dogs and 10 overs are lost from the innings. When play resumes there are only 10 overs left but there are still, of course, 2 wickets down, and the table now tells us that the percentage resources remaining P(10, 2) is 30.8 per cent. Due to the shortening of the innings the team has lost a resource percentage of 52.4–30.8 = 21.6 per cent. Having started with a resource percentage of 100 per cent and lost 21.6 per cent, then if they complete their innings with no further loss of overs, they will have had a resource percentage available for their innings of 100 − 21.6 = 78.4 per cent.

What to say about the second step? It transforms the number of expected runs into a percentage of resources left. This is done by dividing the expected outcome by the average expected outcome thereby assuming that the expected outcome will never be higher than 235. This implies that the formula to calculate the actual expected outcome is designed to deliver outcomes in the interval 0–235. Since 235 is an average, one could reasonably expect that a lot of games have outcomes above 235. It seems strange that an average (which, moreover, is an arbitrary number) is set as a maximum. The problems this causes will be scrutinized at length in the next section. It should be noted that the users of the D/L method do not have to make any of these calculations themselves. They are only advised to learn to apply the table of resource remaining percentages and to proceed with step three.

Finally, the third step proposes a way to establish the victory target. Take S to be Team 1's total score and P1(u,w), or P1 for short, is the resource percentage (relative to a full 50-over innings) available to Team 1 and, similarly, P2 is the resource percentage remaining for Team 2. T is Team 2's target score. If P2 differs from P1 a revised target must be set. Calculate this revised target as follows:

If P2 < P1, that is, if Team 2 has fewer resources available than Team 1, Team 2's revised target is obtained by reducing Team 1's score S in the ratio of P2 to P1, ignoring the figures after the decimal point, and adding one run, that is,

$$T = \left(S.\frac{P2}{P1}\right) + 1.\ \text{(Henceforth referred to as situation A.)}$$

If P2 = P1, no revision is needed and Team 2's target is one more run than team 1's score, that is, $T = S + 1$.

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If P2 > P1, that is, if Team 2 has more resources available than Team 1, calculate the amount of excess P2–P1, and take this percentage of the average 50-over total, G50 = Z(50,0), to give the extra runs needed, ignoring any figures after the decimal point, that is,

$$T = [S + (P2 - P1).G50/100] + 1. \text{ (Henceforth situation C.)}$$

Q4

What to say about the third stage? Here the rule reveals its main goal: the proportion of the actual runs scored by Team 1 over the target score of Team 2 should reflect the proportion of resources remaining (see situation A). However, a simple proportional solution – 'scaling down' using the ratio of the resources available – is not available in situations like C. Let me illustrate this significant difference by means of examples of situation A and situation C, respectively.

I shall continue with an earlier example to illustrate situation A. [5] Team 2 has lost 2 wickets in scoring 120 runs in 30 overs. Play is then suspended and 10 overs are lost. Team 1 has scored 200 runs from their 50 overs. What is Team 2's revised target? I calculated above that Team 2's remaining resource percentage is 78.4 per cent. Team 2 had clearly less resource available (78.4 per cent) than Team 1 (100 per cent) and so to obtain the target, Team 1's score must be scaled down by the ratio of resources available, 78.4/100. Team 1 scored 200, so Team 2's target is 200 × 78.4/100 = 156.8 which rounds down to 156 to tie with a revised victory target of 157. Team 2 thus requires a further 37 runs to win from 10 overs with 8 wickets in hand.

In situation C, Team 1 has less resources available than Team 2 which is typically due to an interruption to Team 1's innings. Suppose Team 1 has lost 5 wickets in scoring 150 runs in 40 overs from an expected 50 when rain terminates Team 1's innings. From the table one could derive that the premature end to their innings has deprived Team 1 of the 26.1 per cent resource percentage they had remaining (P(10,5)). Having started with 100 per cent they have had 73.9 per cent resources available for their innings. When the extended spell of rain is over only 40 overs are left in Team 2's innings. What is then the target for Team 2? Since Team 2 also faces a curtailment of its innings, the resource percentage available has to be deduced from the table: P(40, 0) = 89.3 per cent. Team 2 thus has more resources than Team 1 had (89.3–73.9 = 15.4 per cent more) and so they are set a target which is enhanced by 15.4 per cent of 235, or 36.2 runs. Using the sum 150 + 36.2 = 186.2, rounding down gives 186 to tie and Team 2's victory target is 187 in 40 overs.

It strikes many as odd that the target should be revised upwards in a case where both sides bat an equal number of overs. Indeed, most rain rules would set the target of 150 because both teams face the same number of overs. The argument forwarded by those who devised the D/L method against setting the target to 150 is, however, crucial to the present argument. It runs along the lines of the following: Team 1 were pacing their innings to last 50 overs when it was curtailed. Team 2 know in advance of the reduction of their innings to 40 overs. This is clearly an injustice to Team 1 since Team 2 have been handed an unfair advantage. D/L compensates this by setting Team 2 an increased target relative to the number of runs Team 1 actually scored. This means that the D/L rule assumes that run-scoring accelerates at the end of the innings and, in the context of retargeting, losing the first 10 overs of an innings counts less than suddenly losing the last 10 overs. This specific feature will play a crucial role in the next section where the D/L method as a whole will be evaluated.

What's the D/L Method Good for Anyway?

The D/L method has many advantages, which make it undoubtedly preferable to all previously used retargeting rules. What are these advantages? It is possible, I believe, to reach some kind of consensus over the virtues of any given rain rule. Without aiming to provide an exhaustive list of such desirable properties, the following broad features can be cited as conditions of a good rain rule: completeness (the rule must be able to handle all kinds of interruptions, even multiple interruptions and other unusual situations); consistency (the underlying mathematical model must be internally consistent); comprehensibility (calculations must be straightforward, tables easily accessible, or computer programmes user-friendly); realism (the rule should preserve the chance of winning, that is, the reset target should be realistic); [6] impartiality or strategic neutrality (no team should be strategically (dis)advantaged); and last but not least fairness. The cricketing community at large seems to be in agreement that the D/L rule scores excellently on the first four features. However, opinions are divided on the question as to whether the D/L rule is impartial and/or fair. Let us examine to what extent the D/L rule possesses the latter features beginning with impartiality.

Some commentators have provided substantial evidence of a lack of impartiality. Chetan Shah [7] refers to the asymmetrical equations for resetting targets depending on whether P1 > P2 (situation A) or P2 > P1 (situation C). The author expresses his discontent as follows:

> Though the asymmetry cuts both ways ... it favours Team 2 when it matters. To put it loosely, [the equation for situation C] damps Team 1's performance when it is playing well and boosts it when it is doing badly. This is a Welfare Ethic – Tax the Haves and subsidise the Have Nots. Contrariwise, Team 2 has its performance amplified or subdued in the same direction as its early showing. A Free Market System where the rich get richer and the poor poorer. The twin policies deny Team 1 the cutting edge at the high end where it is most valuable. [8]

Honesty requires me to say that in practice the equations deliver acceptable results in most situations. Without going into technicalities, it is only in cases where few statistics are available (typically for interruptions at the beginning of an innings), and when high scores are on the cards that the dampening factor included in the equation may play up. A solution for this problem, though technically possible, would reduce the ease of application of the method by scorers and is for this very reason not introduced by D/L.

Nevertheless this asymmetry between the equations impairs the quality of impartiality and may even lead to strategic options, which are not equally open to both teams. Consider the following instance. When the target is large and Team 2 foresees a substantial reduction of its innings, Team 2 could take the strategic option to keep as many wickets as possible in hand, even if the scoring rate is less than required. A score of 99/1 after 25 overs in the second innings against a target of 286 for 50 overs would win if no further play is possible (and also 110/2, 123/3 140/4, or 161/5 … would do the job). Shah notices that this distorted result is not merely due to the scaling of limited early data but also stems from an idealized assumption of how batting sides deploy their resources during an innings.

Indeed, one of the reasons for adopting asymmetric equations is to account for the timing of the rain interruption(s). As mentioned above, the D/L rule assumes that run-scoring accelerates at the end of an innings. The D/L method thus makes significant assumptions about the way teams spread the use of resources over the length of an innings. Although this should be considered as an important breakthrough of the D/L rule, the fact that a victory target in some cases could be revised upwards stirred up a lot of commotion. Most people find an upwards revised target advantageous for Team 1. The D/L rule assumes that run-scoring accelerates which is a highly improbable assumption, critics say, since cricket is a game of uncertainties. I do not think this is as great a problem as some might believe. Each rain rule has to make assumptions about the run-scoring trajectory in lost overs. It is not the fact that one makes assumptions that is problematic, albeit that the assumptions themselves are open to discussion. I am sympathetic to the idea that the point during the innings at which the interruption occurs matters for the game. Losing the first 10 overs or losing the last 10 overs makes a world of difference. One could however ask questions whether this general idea has been applied consistently. I believe that losing a couple of overs during the period of field restrictions reduces a team's resources more than when one loses the same couple of overs somewhere between over 25 and 30. Many will agree that the first period has much higher run-scoring capacity than the second but the D/L rule unfortunately does not reflect this. D/L assumes an exponential relationship between runs and overs meaning that run-scoring accelerates right from the beginning of an innings. Loosely speaking: the more overs gone, the faster runs come.

Apart from the fact that distortions may occur due to atypical early data and the assumptions made about run-scoring capacity, the specific role of the average ($G50 = 235$) in the method might also bring D/L into trouble. The problem occurs in low-scoring matches (for example, Team 1 scores about 120 to 130 runs) usually as a result of difficult batting conditions. If then $P2 > P1$, the target is revised upwards and might seem too high. The D/L method assumes that, on average, Team 2 is expected to total 235 in a complete innings. If Team 2 is only able to total about 140 runs the assumption that they will get to 235 is unrealistic. And it is this postulation that causes prima facie an abnormally high target.

A similar objection refers to the situation where the total set by Team 1 is much greater than average and the D/L rule consequently sets 'well below average' winning targets for Team 2. This objection eventually forced D/L to adjust the method, leading to the introduction of the entirely computerised Professional Edition in 2003. Duckworth and Lewis were at this point forced to sacrifice their admirable aim that it should be possible to apply the method using just a pocket calculator and a single table. However, this leads me to an even more profound criticism, namely the ad hoc nature of the rule as a whole. The rule is changed almost yearly to adjust for technical anomalies or for situations in which the outcome seems unfair. This, as such, is not wrong – it is certainly not elegant – but more worrying is that the adjustments do not proceed from a coherent underlying theory of what a rain rule should do, a well-founded hierarchy of aims, nor any explicit concept of fairness. Certain technical adjustments are introduced at the expense of one of the method's core aims (that is, easy application) while other such adjustments, which would also require the aid of a computer, are overlooked, without explanation. What this method seems to require – in addition to the excellent skills of enthusiastic statisticians – is an ethically well-founded vision of what a fair rule should look like.

Fairness therefore is a big issue. When cricket fans or commentators disagree with the outcome of the retargeting, arguments often appeal to one's intuition of fairness. One then complains that the target 'seems grossly unfair' or one asserts that 'many will consider this target as unfair'. We have all encountered this kind of talk. Fairness, however, is rarely ever defined. What it involves is assumed or invoked by a vague appeal to intuition. One's intuition is often a good starting point for an argument but should at least be made explicit. In my view, a rain rule could be labelled fair if the outcome of the rule is in accordance with the rules, the spirit of cricket and all that is valued in its traditions. What this all involves is spelled out in the next section.

In Defence of a Responsibility-sensitive Egalitarian Approach

Rain rules and the D/L rule in particular have mainly been the field of statisticians and mathematicians. The D/L method is undoubtedly a correct method from a purely technical point of view. It is well-designed and integrates sophisticated technicalities. There is, however, more that can be included than techniques and statistical skills. The spirit of the game, for one, should be an integral aspect from the outset. Until now it has only been implied in a consequentialist manner. When the consequences of the retargeting process have clearly not been in accordance with the spirit of the game, D/L made some ad hoc adjustments.

Let us first determine what the exact aim of a rain rule should be. It is, I believe, to level the playing field as much as possible or, more precisely, to restore equality of opportunity for both teams in the event of it being undermined by the interruption. This rather general aim could be interpreted in a number of ways. Some [9] defend that the aim should be to preserve the probability of victory. For the D/L rule, the aim is to maintain the difference between the teams. 'The D/L method maintains the margin of advantage. It does not maintain the probability of winning or losing.' [10] Or one could come up with the idea of equalizing the resources (by, for instance, revising the number of overs to be played and/or the number of wickets available).

I am convinced however that the spirit of cricket should be used as a basis upon which to construct a rain rule. Furthermore, I forward that the ideals implicit in the spirit of the game are reflected exceptionally well within the essence of an egalitarian orientation to ethics sensitive to the concept of responsibility. The responsibility-sensitive egalitarian ethic is a way of combining the concepts of responsibility and equality in a comprehensive and consistent way. [11] It reflects the philosophical debate on egalitarianism in the realm of (distributive) justice that began with Rawls [12] and spawned a series of influential articles by Dworkin, [13] Scanlon, [14] Arneson, [15] Cohen [16] and others. Basically these egalitarians all encountered a fundamental problem when shaping their egalitarian theory: equality (of income, for instance) is never a steady state since there is an almost natural tendency to deviate from equality through the voluntary actions of individuals and/or involuntary events, incidents or contingencies. Some people spoil whatever they have voluntarily while others lose all because they are struck by bad luck. Theorists are then confronted with the dilemma whether to restore equality and, if so, to what degree. While none argue that all inequality is necessarily unjust (and that it should therefore be completely eradicated), few authors agree on the exact cut (and the criteria with which to make that cut) between what should be restored and what should not. Dworkin for instance argues that inequalities that stem from preferences with which individuals identify themselves should not be levelled out whereas inequalities which arise from resources should be. Arneson and Cohen, on the other hand, defend that inequalities arising from voluntary actions should be maintained whereas those resulting from involuntary events should be adjusted. Since there are 'involuntary preferences' and 'voluntary resources' both approaches are not simply interchangeable. The responsibility-sensitive egalitarian ethic takes a particular stance in this discussion while at the same time leaving some normative choices available.

A responsibility-sensitive egalitarian ethic could in this context be defined as follows: it is unfair if there is inequality among the teams due to factors which are beyond their responsibility; whereas such inequality is considered fair if due to the exercise of their responsibility. The normative question on the cut between the factors within and beyond the ambit of responsibility has a straightforward answer in this context: everything that has to do with the responsibility or choices of the teams (strategy, tactics, overall quality and condition of the players selected for the team, decision to bowl or to bat after the toss, etc.) are to be called responsibility variables and everything that is beyond the responsibility or the choice of the teams (external conditions, rain, timing of the interruption, light, etc.) should be termed compensation variables. Any revisional rule should adjust for differences in opportunities due to compensation variables but should keep differences in opportunities resulting from responsibility variables intact. Loosely speaking, the

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fruits of a team's own strategic choices and overall performance should not be hampered by external events that undermine the equality of opportunity between the teams. [17] This, I feel, is part of the essence of the spirit of cricket. It is arguable, then, that if a rain rule satisfies this kind of equality of opportunity, people will feel that the revised targets are fair!

If the cricket community agrees on this fundamental starting point, a couple of recommendations could be formulated for a fair(er) rain rule. At a conceptual level, this ethics implies that the actual run-scoring trajectory should be reflected in the revised target as much as possible. As is often emphasized in modern cricket, the trade-off between making runs and losing wickets is an important consideration in strategic decision-making. Since this element of the game is incorporated in the runs and resource percentage remaining, it should be reflected in the reset target. This is something for which the teams should be held responsible and therefore rewarded/penalised. The use of the arbitrary average of 235 in parts of the D/L rule at various times misses the mark, particularly in low scoring matches (see above). This element of the D/L prevents the target from reflecting the actual performance of the teams and is for that reason not very fair.

A second recommendation could be advanced along similar lines. The point at which an interruption occurs should affect the target. The moment of the interruption is beyond the responsibility of the team – it is bad luck – and should for that very reason be compensated for. Losing overs, for example, during the period where field restrictions are in place is worse for the batting team than losing overs when there are no longer any restrictions. The D/L model does not sufficiently account for this. [18]

It is likely that a lot of the commotion surrounding the D/L rule would die down if the D/L rule could be (re)built from its foundations with an eye to this kind of normative framework. However, I do not claim that implementing such an ethic is easy from a technical point of view. Some aspects of the game depend upon both internal decisions and on external factors and these separate influences cannot be easily disentangled (that is, non-separability between compensation and responsibility variables). Where scores are taken as a proxy for (or direct index of) performance, for instance, responsibility aspects (as performance) combine with elements of luck, which are compensation variables. Nevertheless, it is not beyond the realm of conceivability that a technique could be developed in line with this kind of thinking, as it has some precursors in other contexts. In the context of distributive justice, for instance, technical (re)distribution mechanisms are worked out upon the foundation of a set of axioms, which, in combination, express the responsibility-sensitive egalitarian ethic. [19] Such an axiomatic approach generates satisfactory results (even in the case of non-separability). If, however, it turns out to be impossible to design a rain rule satisfying our concept of fairness (or in the meantime), one could shift to an existing rule, [20] which in my view already incorporates our ethics quite well (without being explicitly built upon this ethic in a fundamental way as advocated above).

Jayadevan developed a rain rule, which bears some similarities with the D/L rule but deviates from it in certain important respects. It is not my intention to explain this rule in depth. I only wish to point to some striking differences from the D/L rule, the way it expresses the responsibility-sensitive egalitarian ethic and where there is room for improvement in this respect.

Loosely speaking, Jayadevan's method combines, in a clever way, percentages of wickets lost, overs completed and runs scored. He does not translate the former two into one percentage of 'resources remaining' as in D/L. An even more crucial difference is the type of mathematical function employed. The D/L method assumes an exponential function to describe the rate of reduction of resources as the overs get used up and/or the wickets fall. It means that they assume that run-scoring ability accelerates right from the first ball. This captures the fact that run-scoring accelerates at the end of an innings but overlooks the fact that there is normally a moment of stabilization somewhere after the relaxing of the field restriction (which in itself is considered as a period high in scoring opportunities). Jayadevan's method, however, assumes seven different periods within one innings and lets the data of past matches do the talking. He employs a regression fit and a cubical polynomial function which expresses that run-scoring first accelerates, then settles down a bit and accelerates again towards the end of an innings. 'Since the curve is developed based on data at different stages of the match, it so happens that this curve lies closer to the actual match situation than the D/L curve.' [21] This meets the (second) recommendation given by the proposed ethics: a fair rule should suitably account for the timing of the interruption. The Jayadevan method out performs the D/L rule on this point.

Another difference between both methods is the absence of any role for G50, the average score in a 50 overs innings, in the Jayadevan model. The latter model extensively uses the data of the match in progress to determine the target. In situations like C, the target is scaled up using the ratio of the same variables as to scale down the target in situations like A. This implies that Team 2's target is always proportional to Team 1's score. Jayadevan thus avoids the rather awkward asymmetrical treatment of situations A and C and all the evils that result from it. Recall the (first) implication of our ethics: the revised target should preserve the actual run rate trajectory as much as possible. I believe that Jayadevan does a better job than D/L in this respect since the arbitrary 235 is eliminated.

In addition to an appropriate appeal to fairness and other such advantages, [22] the Jayadevan model has some drawbacks. The use of the rule is slightly more complicated, especially in the case of multiple interruptions, and his justification for the method employed in constructing the two curves (that is, the target and the normal curve) are not convincing. On this limited evidence at least, the Jayadevan model seems to satisfy the responsibility-sensitive egalitarian ethic, which I take to represent the concept of fairness in cricket, in a more satisfactory manner than the D/L method.

Conclusion

Most cricket matches are played outdoors, thus causing some of them to be curtailed by external factors like rain. When this situation arises, it is necessary to adjust the teams' scores in such a way to be able to hail a 'fair' winner at the end of the day. Many rules have been put forward to maintain fairness between the teams but none have proven to be wholly satisfactory. The D/L method is devised to improve 'fairness' in cases of weather-affected matches. The D/L method revises the target in accordance with the relative resources available (overs left, wickets in hand) to the two teams. If interruptions cause Team 2 to have fewer resources available, then their target will be scaled down. If, on the other hand, the stoppages result in Team 2 having more resources available then their target is revised upwards to correct for the extra resources.

The introduction of the D/L rule is definitely a great leap forward. Besides possessing the right amount of technical qualities, it has other attractive features such as completeness, consistency, comprehensiveness and realism, properties universally considered virtues of a good rain rule. Above all, however, a good rule should reflect the spirit of the game.

Apart from specific criticisms related to the respective results of D/L retargeted matches, some objections are important from a more philosophical point of view. Significant criticisms are raised concerning the lack of impartiality, the intrusion of such arbitrary elements as the G50, the general ad hoc nature of the method and the absence of an explicit and valid view on the meaning of fairness. An ethical underpinning of rain rules is sorely missed. It has been the purpose of this essay to employ contemporary insights from egalitarian theory formulating an account of what such a normative framework could look like. Such an account could either act as a source of inspiration during the process of designing rain rules or as a touchstone of fairness. Fairness, as an essential part of the spirit of cricket, implies that rain rules should leave the domain of any given team's responsibility untouched, while restoring equality of opportunity via compensation (retargeting) in cases of obvious bad luck or events beyond a team's responsibility.

This analysis has taught us at least one important lesson: all future innovations in the game should be assessed in accordance with both the rules and (a more explicit account of) the spirit of cricket. There are seemingly endless proposals at present for new innovations in the game, many designed with a view to levelling out the effects of external conditions. This evolution emphasizes the need for a strong criterion. What does fairness and, by extension, the spirit of cricket mean? Consensus on these and other philosophical questions should be the first step in considering such innovations to the game of cricket. It has been the aim of this essay to provide a modest initial impetus to the development of such a normative framework but refinements are certainly needed. One could come up with other frameworks, which are potentially even more plausible. However, what needs to be stressed is that such explicit ethical underpinning, whatever form it may take, is indispensable to the project of securing fairness in the game. Perhaps then the whole cricketing community could confidently claim we are all equal under the sun ... and in the rain.

Notes

[1] Other examples include baseball and (individual or team) time trials on a single track as in skiing, rally sport, cycling, speed ice skating, bobsleigh, etc.

[2] A famous example is the match between South Africa and England to reach the finals of the 1992 World Cup. South Africa saw their target of 22 runs from 13 balls change to 21 runs from just one ball when a spell of rain took two overs away.

[3] Duckworth and Lewis, 'A Fair Method of Resetting the Target in Interrupted One-Day Cricket Matches', and *Your Comprehensive Guide to the Duckworth/Lewis Method for Resetting Targets in One-Day Cricket*.

[4] The D/L method was updated in 2002 to take account of higher scoring in recent times. The average 50-over score has at that occasion been increased from 225 to 235.

[5] Since it is not our main aim to explain the application of the D/L rule, the reader is referred to comprehensive guides to the D/L rule for the calculation of examples with multiple stoppages, penalty runs and other complicated examples. Let me add that the D/L rule is able to deal with all these situations and scorers only need a single table and a pocket calculator.

[6] Again, reference is common to the South Africa versus England match at the 1992 World Cup (see above). The Springbok's feasible target of 22 runs from 13 balls was transformed into an impossible and therefore unrealistic 21 runs from one ball. Under the D/L rule, South Africa would have had to score 3 runs off the last ball.

[7] Shah, 'Cricket Come Rain or Shine – I'; 'Cricket Come Rain or Shine – II'.

Q5 [8] Shah, 'Cricket Come Rain or Shine – II'. For a similar comment see Preston and Thomas, *Rain Rules for Limited Overs Cricket and Probabilities of Victory*, 9: 'If the team batting first is doing well then the opposing team would need to aim at a higher run rate than otherwise and to the extent that the D/L rule does not take account of this it appears that it should favour teams already performing well.'

[9] Preston and Thomas, *Rain Rules for Limited Overs Cricket and Probabilities of Victory*.

[10] Duckworth and Lewis, *Your Comprehensive Guide to the Duckworth/Lewis Method for Resetting Targets in One-Day Cricket*, 27.

[11] See for example, Fleurbaey, 'On Fair Compensation'; 'Equality and Responsibility'; and 'Equal Opportunity or Equal Social Outcome?'

[12] Rawls, *A Theory of Justice*.

[13] Dworkin, 'What is Equality? Part 1' and 'What is Equality? Part 2'.

[14] Scanlon, 'Equality of Resources and Equality of Welfare: A Forced Marriage?' and 'The Significance of Choice'.

[15] Arneson, 'Equality and Equal Opportunity for Welfare'; 'Liberalism, Distributive Subjectivism, and Equal Opportunity for Welfare' and 'A Defence of Equal Opportunity for Welfare'.

[16] Cohen, 'On the Currency of Egalitarian Justice,' and 'Equality of What? On Welfare, Goods and Capabilities'.

[17] It is clear that the Australian Rain Rule (see above) is a blatant example of a rule which does not satisfy the responsibility-sensitive egalitarian ideal since the team bowling maiden overs is deprived of the fruits of its excellent bowling.

[18] A thorough reflection of the proposed ethics would no doubt generate more recommendations but these seem to be the most relevant implications for a normative analysis of the D/L rule.

[19] Bossert, 'Redistribution Mechanisms Based on Individual Characteristics'.

[20] Jayadevan, 'A New Method for the Computation of Target Scores in Interrupted, Limited-Over Cricket Matches'.

[21] Ibid., 583.

[22] Recall the partiality objection against the D/L rule in low scoring matches (see above). Jayadevan would have required Team 2 to score 119/1, 123/2, 148/4 or 172/5 in 25 overs to win which seems much more acceptable.

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